



## New Records of Euglenophyceae for Turkish Freshwater Algae

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### Abstract

Phytoplankton samples were collected from four different water bodies in the Tigris River basin in 2008. Nine Euglenophyceae taxa at specific and infraspecific level are reported for the first time on Turkish freshwater algal flora. New records come from six sampling sites in the study area. These taxa consist of one *Euglena* Ehrenberg (*E. sociabilis*), two *Strombomonas* Deflandre (*S. planctonica* and *S. pascheriana*), four *Trachelomonas* Ehrenberg (*T. nigra*, *T. aspera*, *T. borodiniana* and *T. scabra* var. *labiata*) and two *Phacus* Dujardin (*P. inflexus* and *P. ovalis*). Identification keys and general information on the morphology and taxonomy of the species are briefly described in this paper, with original illustrations.

**Keywords:** Euglenophyceae, new records, freshwater algal flora, Tigris River basin, Turkey.

### Türkiye Tatlısu Algleri için Yeni Euglenophyceae Kayıtları

#### Özet

2008 yılında Dicle Nehri havzasındaki dört farklı su kütesinden fitoplankton örnekleri toplandı. Türkiye tatlısu algal florası için ilk kez spesifik ve infraspesifik düzeyde dokuz Euglenophyceae taksonu rapor edilmektedir. Yeni kayıtlar çalışma alanındaki altı örnekleme sitesinden elde edildi. Yeni kayıtlar, bir *Euglena* Ehrenberg (*E. sociabilis*), iki *Strombomonas* Deflandre (*S. planctonica* ve *S. pascheriana*), dört *Trachelomonas* Ehrenberg (*T. nigra*, *T. aspera*, *T. borodiniana* ve *T. scabra* var. *labiata*) ve iki *Phacus* Dujardin (*P. inflexus* ve *P. ovalis*) taksonlarından oluşmaktadır. Bu makalede, türlerin morfolojisi ve taksonomisi ile ilgili teşhis anahtarları ve genel bilgiler, orijinal resimlerle birlikte kısaca tanımlanmaktadır.

**Anahtar Kelimeler:** Euglenophyceae, yeni kayıtlar, tatlısu algal flora, Dicle Nehri havzası, Türkiye.

### Introduction

The level of knowledge about the Euglenophyceae of Europe compares well with that from other continents. Studies on euglenoids were performed in the last decade of the 19th century and intensively in the beginning of the 20th century in Europe. From the territory of the present-day Czech Republic there are data on Euglenophyceae reported by Hansgirg (1886). From Germany there are works of Lemmermann (1910, 1913) including data about all groups of algae. A very good study of the genus *Trachelomonas* from France was done by Deflandre (1926). Later, Conrad and Van Meel (1952) made a major contribution to the euglenophyte flora of Belgium and France. Some of the most important data were elaborated by Skuja (1956), who gave original, very detailed information on all euglenophytes, together with the best iconographic

documentation for Sweden. Huber-Pestalozzi (1955) and Starmach (1983), compiling data on the euglenophytes of almost the whole globe, greatly contributed to the development of research on euglenoids. Popova (1966) and Popova and Safonova (1976) published good monographs on the flora of the Soviet Union. Vetrova (1986) gathered information about colourless and green euglenophytes from Ukrainian continental waters. We can find important data and documentation for *Euglena* from Poland in Zakryś (1986) and Wołowski (1998); the latter included data on the colourless and green euglenophytes of the Krakow-Czestochowa Upland. Nemeth (1997) studied the euglenophytes of Hungary.

Kusel-Fetzmann (2002) published the results of her long-term observations of the euglenophyte communities of Austria. A large body of data from Slovakia and Poland was elaborated by Wołowski and

Hindak (2005) and published in a coloured atlas of euglenophytes, with keys for 15 genera. Wołowski (2011) described the Euglenophyceae flora of the United Kingdom, based on his own and historical data. Most of these works are connected with Western, Northern, Central and Eastern Europe. We need more studies of the Euglenophyceae of Southern Europe and adjacent areas.

Taxonomic and floristic studies of Euglenophyceae in Turkey are still scarce, and, as in many other countries, are usually part of works that include other algal groups. The highly diverse inland waters of Turkey have seen a marked increase in the number of algological studies in recent years. In the check-list of the freshwater algae of Turkey by Aysel (2005), a total of 2030 taxa at specific and infraspecific level were reported, 159 of which were Euglenophyceae. Later, 12 freshwater euglenophytes were recorded for the first time for Turkey by Maraşlıoğlu *et al.* (2005), Soylu *et al.* (2007), Sevindik *et al.* (2010, 2011 and 2015) and Özer *et al.* (2012), making a total of 171 taxa. This is only 16.19% of the 1056 species of Euglenales reported worldwide (Guiry and Guiry, 2016). The Tigris River is one of the Turkey's most important rivers but the euglenophytes and other algae of the Tigris River basin is still poorly known (Özer *et al.*, 2012; Varol and Şen, 2014). The aim of this study was to contribute the algal flora of the Tigris River basin, with special attention to Euglenophyceae.

## Material and Methods

### Study area

The Tigris River originates in the Toros Mountains of Eastern Anatolia. It follows a south-eastern route to Cizre, where it forms the border between Turkey and Syria, and then runs a further 32 km before entering Iraq. Of its ca. 1900 km total length, 523 km (draining 57,614 km<sup>2</sup>) is within Turkey (Varol *et al.*, 2013). There are three reservoirs in the Turkish part of the basin: Kralkızı Dam (KDR), Dicle Dam (DDR) and Batman Dam (BDR) (Figure 1). The Kralkızı Dam was erected for hydroelectric power generation (HPG), the Dicle Dam for HPG, irrigation and drinking water supply, and the Batman Dam for HPG, irrigation and flood control (Varol, 2013 and 2016).

### Sampling and Identification

Figure 1 shows the seven phytoplankton sampling sites. Three were in the river, one in KDR, one in DDR and one in BDR. Samples were taken at monthly intervals between May 2008 and October 2008. The samples were collected with a plankton net (55 µm mesh) and examined with a light microscope (Olympus BX51). Photographs were taken using Olympus DP71 digital camera. Taxa were identified according to

Starmach (1983) and Karnkowska-Ishikawa *et al.* (2013). Identified taxa were checked against the checklist of Aysel (2005) and the database of Turkish algae (Gönülol, 2016), and determined as new taxa for Turkish freshwater algal flora. The current accepted nomenclature has been checked with AlgaeBase (Guiry and Guiry, 2016).

## Results

Nine Euglenophyceae taxa new for the freshwater algae of Turkey were identified. These taxa consist of one *Euglena* Ehrenberg (*E. sociabilis*), two *Strombomonas* Deflandre (*S. planctonica* and *S. pascheriana*), four *Trachelomonas* Ehrenberg (*T. nigra*, *T. aspera*, *T. borodiniana* and *T. scabra* var. *labiata*) and two *Phacus* Dujardin (*P. inflexus* and *P. ovalis*). New records come from six sites (B-1, D-1, K-1, T-1, T-2 and T-3). Identification keys and general information on the morphology and taxonomy of Euglenophyceae species and genera presented in this paper are given below.

**Class:** Euglenophyceae

**Order:** Euglenales

**Family:** Euglenaceae

**Genus:** *Euglena* Ehrenberg

**Genus:** *Strombomonas* Deflandre

**Genus:** *Trachelomonas* Ehrenberg

**Family:** Phacaceae

**Genus:** *Phacus* Dujardin

### Key to Genera:

- 1a.** Cells naked without lorica.....**2**  
**1b.** Cells enclosed in lorica.....**3**  
**2a.** Cells flexible, with pronounced euglenoid movement, elongate, sometimes twisted, with one emergent flagellum, chloroplasts with variously developed pyrenoids, paramylon bodies from small grains to large rod-shaped.....***Euglena***  
**2b.** Cells rigid, leaf-shaped, flattened, may be twisted, usually with large ring-shaped or discoid paramylon bodies and with variously developed posterior cauda.....***Phacus***  
**3a.** Cells enclosed in lorica tapering anteriorly, with neck which is only extension of lorica...***Strombomonas***  
**3b.** Cells enclosed by external lorica except apical pore, usually with collar or surrounded by thickening, through which emerges the flagellum, lorica variously ornamented .....***Trachelomonas***

**Genus:** *Euglena* Ehrenberg

***Euglena sociabilis* P.A.Dangeard**

**References:** Karnkowska-Ishikawa *et al.* (2013; page 619, figure 1a-d), Starmach (1983; page 70, figures 90 and 91)

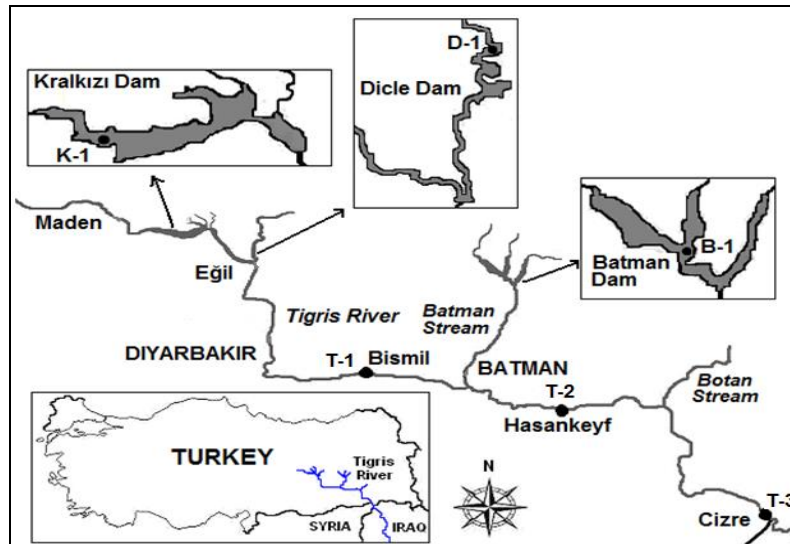


Figure 1. Map the showing the sampling sites in the Tigris River basin.

**Description:** Cells spindle-shaped; 15–27  $\mu\text{m}$  wide, 62–87  $\mu\text{m}$  long; rounded at anterior end, gradually tapering to posterior and passing into short tail-piece; pellicle very delicate, spirally striated; chloroplasts ca. 10 per cell, very deeply lobed, up to centre of cell, each with double-sheathed pyrenoids (Figure 2a).

**Specimens studied:** This species was collected at site T–1 (Bismil; 37° 50' N - 40° 39' E, 538 m a.s.l.) of the Tigris River in May 2008.

**Distribution:** Britain (Wolowski, 2011), Romania (Caraus, 2012), Brazil (Alves-da-Silva and Menezes, 2010), South Africa (Oberholster *et al.*, 2010), Southeastern United States (Wolowski *et al.*, 2013), India (Ratha *et al.*, 2006), New South Wales and Queensland (Day *et al.*, 1995).

**Genus:** *Strombomonas* Deflandre

**Key to species of *Strombomonas*:**

- 1a. Lorica usually with variously developed extension.....2
- 1b. Lorica without extension or sometimes with short one .....3
2. Lorica ovoid or pyriform with straight or rarely curved extension.....*S. planctonica*
3. Lorica broadly cylindrical in outline .....4
4. Lorica longitudinally ovoid, irregularly granulate.....*S. pascheriana*

***Strombomonas planctonica* (Woloszynska) Popova**

**Basionym:** *Trachelomonas affinis* var. *planctonica* Woloszynska

**Synonym:** *T. affinis* var. *planctonica* Woloszynska

**References:** Starmach (1983; page 260, figure 569)

**Description:** Lorica egg-shaped or pyriform, 18–32  $\mu\text{m}$  wide, 27–50  $\mu\text{m}$  long, gradually narrowed at anterior end into neck; at posterior end passing into conical, straight or slightly curved extension; wall rough, brown (Figure 2b).

**Specimens studied:** This species was collected at site T–1 (Bismil; 37° 50' N - 40° 39' E, 538 m a.s.l.) in September 2008.

**Distribution:** Romania (Caraus, 2012), Brazil (Alves-da-Silva and Menezes, 2010), Israel (Barinova and Tavassi, 2009), New Jersey (Conforti, 2009) and Russian Far East (Medvedeva and Nikulina, 2014).

***Strombomonas pascheriana* (Skvortzow) Deflandre**

**Basionym:** *Trachelomonas pascheriana* Skvortzow

**Synonym:** *T. pascheriana* Skvortzow

**References:** Starmach (1983; page 242, figure 517)

**Description:** Lorica elongate-ovoid, 37–40  $\mu\text{m}$  long, 18.5–23  $\mu\text{m}$  wide; walls thick, dark brown, irregularly granulate and punctate; chloroplasts 6–10 (Figure 2c).

**Specimens studied:** This species was collected at site T–3 (Cizre; 37° 19' N - 42° 11' E, 371 m a.s.l.) of the Tigris River in October 2008.

**Distribution:** China (Skvortzow, 1925).

**Genus:** *Trachelomonas* Ehrenberg

**Key to species of *Trachelomonas*:**

- 1a. Lorica elliptic .....2  
 1b. Lorica obovoid or irregularly elliptic .....3  
 1c. Lorica oval .....4  
 2a. Lorica without collar, apical pore surrounded by several large verrucae.....*T. nigra*  
 2b. Lorica with well developed collar.....*T. aspera*  
 3. Wall rough, slightly conical at posterior end .....*T. borodiniana*  
 4. Lorica oval, usually covered by particles of exogenous material.....*T. scabra* var. *labiata*

### *Trachelomonas nigra* Svirenko

**References:** Starmach (1983; page 329, figures 751, 751a)

**Description:** Lorica broadly ellipsoid, 23–23.5 µm long, 19–19.5 µm wide, dark brown or black, wall punctate, covered with small single verrucae or short spines, especially at posterior end, apical pore surrounded by several large verrucae (Figure 2d).

**Specimens studied:** This species was collected at site B–1 (38° 11' N - 41° 09' E, 652 m a.s.l.) of the Batman Dam Reservoir in October 2008.

**Distribution:** Israel (Stupina *et al.*, 2000), Czech Republic (Hindak *et al.*, 2006) and Bulgaria (Dimitrova *et al.*, 2014).

### *Trachelomonas aspera* A.M.Cunha

**References:** Starmach (1983; page 347, figure 832)

**Description:** Lorica elliptic, 20–25 µm long, ca. 15 µm wide, light brown, covered with irregular tubercles; collar well developed, cylindrical with smooth edges; flagellum 2–3 times longer than lorica; stigma large; chloroplasts 10 in each cell, plate-shaped with pyrenoids (Figure 2e).

**Specimens studied:** This species was collected at site T–3 (Cizre; 37° 19' N - 42° 11' E, 371 m a.s.l.) of the Tigris River in August 2008.

**Distribution:** Brazil (Alves-da-Silva and Menezes, 2010) and Israel (Barinova and Tavassi, 2009).

### *Trachelomonas borodiniana* Svirenko

**References:** Starmach (1983; page 329, figure 749)

**Description:** Lorica obovoid, 23–28 µm long, 13–15–(22) µm wide, slightly widened at anterior part, slightly conical at posterior end; apical pore without collar, surrounded by thickening; wall rough, plate-shaped (Figure 2f).

**Specimens studied:** This species was collected at site

D–1 (38° 22' N - 40° 12' E, 710 m a.s.l.) of the Dicle Dam Reservoir in August 2008.

**Distribution:** Taiwan (Shao, 2009).

### *Trachelomonas scabra* var. *labiata* (Teiling) Huber-

Pestalozzi

**Basionym:** *Trachelomonas labiata* Teiling

**Synonym:** *T. labiata* Teiling, *T. uniformis* Skvortzow

**References:** Starmach (1983; page 347, figure 827)

**Description:** Lorica oval, granulate, brownish; 16.2–18.5 µm wide, 20.0–22.2–25.0 µm long, anterior end slightly narrowed, with short, not well developed, irregular neck; posterior end slightly narrowed into short extension ca. 1.8 µm long; chloroplast disc-shaped, ca. 3 µm in diameter, with pyrenoids (Figure 2g).

**Specimens studied:** This species was collected at site T–1 (Bismil; 37° 50' N - 40° 39' E, 538 m a.s.l.) of the Tigris River in September 2008 and site K–1 (38° 21' N - 39° 52' E, 790 m, a.s.l.) of the Kralkızı Dam Reservoir in August 2008.

**Distribution:** New South Wales and Victoria (Day *et al.*, 1995), Poland (Poniewozik, 2009), Czech Republic (Kocarkova *et al.*, 2004) and Singapore (Pham *et al.*, 2011).

### Genus: *Phacus* Dujardin

#### Key to species of *Phacus*:

1. Cells oval in outline.....2  
 2a. Cells strongly S-shaped with short projection at posterior end.....*P. inflexus*  
 2b. Cells longitudinally oval with long projection.....*P. ovalis*

### *Phacus inflexus* (I.Kisselev) Pochmann

**Basionym:** *Euglena inflexa* I.Kisselev

**Synonym:** *E. inflexa* I.Kisselev, *Phacus inflexus* var. *minor* Bourrelly & Manguin

**References:** Starmach (1983; page 156, figure 274)

**Description:** Cells flattened, strongly S-shaped, almost folded in two; 20–31 µm long, 7.5–11 wide µm wide, incised at anterior end, with blunt short extension at posterior end; pellicle striated from right to left side; 1–2 paramylon bodies various in size (Figure 2h).

**Specimens studied:** This species was collected at site T–3 (Cizre; 37° 19' N - 42° 11' E, 371 m a.s.l.) of the

Tigris River in July 2008.

**Distribution:** Romania (Caraus, 2012), Spain (Alvarez-Cobelas, 1984), Mexico (Valadez *et al.*, 2010), Brazil (Alves-da-Silva and Menezes, 2010), Sierra Leone (Alfinito, 2011), China (Hu and Wei, 2006) and Taiwan (Shao, 2009).

***Phacus ovalis* (Woronichin) Popova**

**Basionym:** *Phacus longicauda* var. *ovalis* Woronichin

**Synonym:** *P. longicauda* var. *ovalis* Woronichin

**References:** Starmach (1983; page 192, figure 388)

**Description:** Cells longitudinally oval, 87–102 µm long, 42–46 µm, wide, narrowed at posterior end into long appendix ca. 31–33 µm long; periplast longitudinally striated, paramylon grains ring-shaped, one large located in cell centre, smaller located in lower part of cell; chloroplasts small, without pyrenoids (Figure 2i).

**Specimens studied:** This species was collected at site T-2 (Hasankeyf; 37° 42' N - 41° 24' E, 471 m a.s.l.) of the Tigris River in October 2008.

**Distribution:** Russian Far East (Medvedeva and Nikulina, 2014), Ukraine (Bilous *et al.*, 2012) and Taiwan (Shao, 2009).

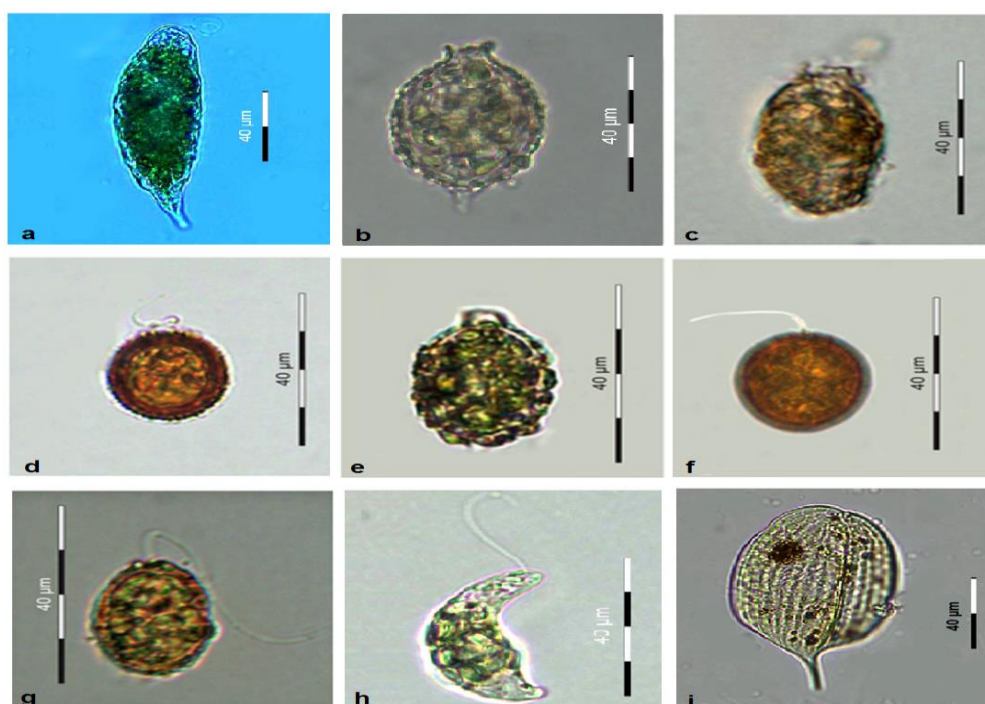
## Discussion

This study reports nine taxa of euglenoids as new records for the freshwater algal flora of Turkey from the Tigris River basin. Most of the taxa found in the basin are well known, and only *Strombomonas pascheriana*, *Trachelomonas aspera* and *T. borodiniana* are rarely reported worldwide (Starmach, 1983; Guiry and Guiry, 2016). All taxa occurred together with other algae such as diatoms (*Navicula*, *Gomphonema*, *Nitzschia*) and chlorococcal green algae. We found that the euglenophyte populations developed very well together with diatoms in almost all the studied samples.

The high number of euglenoids in the water bodies indicates organic pollution (Fjordingstad, 1964; Sladeczek and Perman, 1977; Starmach, 1983; Wołowski, 1998; Wołowski, 2011). Abundant development of euglenoids is also known to indicate high water temperature (Wołowski *et al.*, 2013; Duangjan and Wołowski, 2013; Duangjan *et al.*, 2014). Therefore, knowledge of the euglenophyte flora can be useful in assessment of water quality. This study is offered as a contribution toward determining Euglenophyceae from Turkey.

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**Figure 2.** *Euglena sociabilis* (a); *Strombomonas planctonica* (b), *S. pascheriana* (c); *Trachelomonas nigra* (d), *T. aspera* (e), *T. borodiniana* (f), *T. scabra* var. *labiata* (g); *Phacus inflexus* (h), *P. ovalis* (i).

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## References

- Alfinito, S. 2011. A check list of the freshwater algal flora of Sierra Leone, Tropical West Africa. I. Cyanophyceae to Conjugatophyceae (exclusive of Bacillariophyceae). *Biodivers. J.*, 2: 121-144.
- Alvarez-Cobelas, M. 1984. Catálogo de las algas continentales españolas. II. Craspedophyceae, Cryptophyceae, Chrysophyceae, Dinophyceae, Euglenophyceae, Haptophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae. *Acta Bot. Malacit.*, 9: 27-40.
- Alves-da-Silva, S.M. and Menezes, M. 2010. *Eugleophyceae*. In: Forzza, R.C. (Ed.), Catálogo de plantas e fungos do Brasil. Vol. 1. Andrea Jakobsson Estúdio, Rio de Janeiro, Brasil, pp. 383-404.
- Aysel, V. 2005. Check-list of the freshwater algae of Turkey. *J. Black Sea/Medit. Environ.*, 11: 1-124.
- Barinova, S and Tavassi, M. 2009. Study of seasonal influences on algal biodiversity in the River Yarqon (central Israel) by bio-indication and canonical correspondence analysis (CCA). *Turk. J. Bot.*, 33: 353-372. doi:10.3906/bot-0812-12.
- Bilous, O., Barinova, S. and Klochenko, P. 2012. Phytoplankton communities in ecological assessment of the Southern Bug River upper reaches (Ukraine). *Ecohydrol. Hydrobiol.*, 12: 211-230. doi:10.1016/S1642-3593(12)70205-7.
- Caraus, I. 2012. Algae of Romania. A distributional checklist of actual algae. Univ. Bacau, Bacau, Romania.
- Conforti, V. 2009. Floristic and ultrastructural study of the genus *Strombomonas* (Euglenophyta) from New Jersey fresh waters. *Algol. Stud.*, 132: 1-20. doi: 10.1127/1864-1318/2009/0132-0001.
- Conrad, W. and Van Meel, L. 1952. Materiaux pour une monographie de *Trachelomonas* Ehr. 1834, *Strombomonas* Defl. 1930 et *Euglena* Ehr. 1832, genres d'Euglénacees. *Inst. Roy. Sci. Nat. Belg.*, 124: 1-176.
- Day, S.A., Wickham, R.P., Entwisle, T.J. and Tyler, P.A. 1995. Bibliographic check-list of non-marine algae in Australia. *Flora of Australia Supplementary Series*, 4: 1-276.
- Deflandre, G. 1926. Monographie du genre *Trachelomonas* Ehr. André Letos, Nemours.
- Dimitrova, R., Nenova, E., Uzunova, B., Shishinova, M. and Stoyneva, M. 2014. Phytoplankton Composition of Vaya Lake (2004-2006). *Bulg. J. Agric. Sci. J.*, 20: 165-172.
- Duangjan, K., Wołowski, K. and Peerapompisal, Y. 2014. New records of *Phacus* and *Monomorphina* taxa (Euglenophyta) for Thailand. *Polish Bot. J.*, 59: 235-247. doi: 10.2478/pbj-2014-0039.
- Duangjan, K. and Wołowski, K. 2013. New taxa of loricate euglenoids *Strombomonas* and *Trachelomonas* from Thailand. *Polish Bot. J.* 58: 337-345. doi: 10.2478/pbj-2013-0033.
- Fjerdingstad, E. 1964. Pollution of streams estimated by benthic phyto-microorganisms I. A saprobic system based on communities of organisms and ecological factors. *Int. Revue. Ges. Hydrobiol. Hydrogr.*, 49: 63-131.
- Gönülol, A. 2016. Turkishalgae electronic publication, Samsun, Turkey. <http://turkiyealgleri.omu.edu.tr> (accessed March 08, 2016).
- Guiry, M.D. and Guiry, G.M. 2016. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. <http://www.algaebase.org> (accessed March 09, 2016).
- Hansgirk, A. 1886. *Prodromus der Algenflora von Böhmen. Die Rhodophyceen, Phaeophyceen und einen Theil der Chlorophyceen*. Prag.
- Hindak, F., Hindakova, A., Marvan, P., Hetesa, J. and Hasler, P. 2006. Diversity, abundance and volume biomass of the phytoplankton of the Morava River (Czech Republic, Slovakia) and the Dyje River (Czech Republic) in November 2005. *Czech Phycol. Olomouc*, 6: 77-97.
- Hu, H and Wei, Y. 2006. *The freshwater algae of China. Systematics, taxonomy and ecology*. Science Pres, Beijing, China (in Chinese).
- Huber-Pestalozzi, G. 1955. *Das Phytoplankton des Süßwassers. Teil 4. Euglenophyceen*. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, Germany.
- Kocarkova, A., Wolowski, K., Poulickova, A. and Novotony, R. 2004. *Trachelomonas* taxa (Euglenophyta) occurred in the pools of Poodri Protected Landscape Area (Czech Republic). *Algol. Stud.*, 114: 67-84. doi: 10.1127/1864-1318/2004/0114-0067.
- Karnkowska-Ishikawa, A., Milanowski, R., Triemer, R.E. and Zakrys, B. 2013. A redescription of morphologically similar species from the genus *Euglena*: *E. laciniata*, *E. sanguinea*, *E. sociabilis*, and *E. splendens*. *J. Phycol.*, 49: 616-626. doi: 10.1111/jpy.12072.
- Kusel-Fetzmann, E. 2002. *Die Euglenophytenflora des Neusiedler Sees (Burgenland, Österreich). Abhandlungen der Zoologisch-Botanischen Gesellschaft in Österreich, Austria*.
- Lemmermann, E. 1910. *Kryptogamenflora der Mark Brandenburg*. Verlag von Gebrüder Borntrager, Leipzig, Germany.
- Lemmermann, E. 1913. *Eugleninae*. In: Pascher, A. (Ed.), *Die Süßwasserflora Deutschlands, Österreichs und der Schweiz*. Gustav Fischer Verlag, Jena, Germany, pp. 115-174.
- Maraşlıoğlu, F., Soylu, E.N. and Gönülol, A. 2005. Seasonal variation of the phytoplankton of Lake Ladik, Samsun, Turkey. *J. Freshwater Ecol.*, 20: 549 - 554. doi: 10.1080/02705060.2005.9664770.
- Medvedeva, L.A. and Nikulina, T.V. 2014. Catalogue of freshwater algae of the southern part of the Russian Far East. *Dal'nauka, Vladivostok, Russia*.
- Nemeth, J. 1997. *Az ostoros algák (Euglenophyta) kishatározója 1. Vízi Természet-és Környezetvédelem (in Hungarian)*, Budapest, Hungaria.
- Oberholster, P.J., Blaise, C. and Botha, A.M. 2010. Phyto-benthos and phytoplankton community changes upon exposure to a sunflower oil spill in a South African protected freshwater wetland. *Ecotoxicology*, 19: 1426-1439. doi: 10.1007/s10646-010-0528-6.
- Özer, T.B., Erkaya, İ.A., Udoh, A.U., Akbulut, A., Yıldız, K. and Şen, B. 2012. New records for the freshwater algae of Turkey (Tigris Basin). *Turk. J. Bot.*, 36: 747-760. doi: 10.3906/bot-1108-16.

- Pham, M.N., Tan, H.T.W., Mitrovic, S. and Yeo, H.H.T. 2011. A checklist of the algae of Singapore. Raffles Museum of Biodiversity Research, National University of Singapore, Singapore.
- Poniewozik, M. 2009. Różnorodność taksonomiczna w obrębie rodzaju *Trachelomonas* (Euglenaceae) w dawnej, małej gliniance. *Fragm. Flor. Geobot. Polonica*, 16: 415–424 (in Polish).
- Popova, T.G. 1966. Flora Sporovych Rastenij SSSR (Flora plantarum cryptogamarum URSS). 8. Evglenovyje vodorosli ('Euglenophyta'). *Uzdatek'stvo Nauka* (in Russian), Leningrad, Russia.
- Popova, T.G. and Safonova, T.A. 1976. Flora Sporovych Rastenij SSSR (Flora plantarum cryptogamarum URSS) 9. Evglenovyje vodorosli ('Euglenophyta'). *Izdatel'stvo Nauka* (in Russian), Leningrad, Russia.
- Rahta, S.K., Jena, M. and Adhikary, S.P. 2006. Euglenophytes from Orissa State, East Coast of India. *Algae*, 21: 61-73. doi: 10.4490/algae.2006.21.1.061.
- Sevindik, T.O., Gönüloğlu, A., Önem, B., Tunca, H. and Arabacı, S. 2015. Thirty new records for Turkish freshwater algal flora from Danamandıra Ponds (Silivri, İstanbul) and North Mollaköy Lake (Sakarya). *Biological Diversity and Conservation*, 8: 4-15.
- Sevindik, T.O., Çelik, K. and Gönüloğlu, A. 2010. Twenty-four new records for the freshwater algae of Turkey. *Turk. J. Bot.*, 34: 249–259. doi: 10.3906/bot-0906-56.
- Sevindik, T.O., Çelik, K. and Gönüloğlu, A. 2011. Twenty new records for Turkish freshwater algal flora from Çaygören and İkizcetepeler reservoirs (Balıkesir, Turkey). *Turk. J. Fish. Aquat. Sc.*, 11: 399–406. doi: 10.4194/1303-2712-v11\_3\_09.
- Shao, K.T. 2009. Catalogue of life in Taiwan. Web electronic publication.
- Skuja, H. 1956. Taxonomische und Biologische Studien über das Phytoplankton schwedischer Binnengewässer. *Nova Acta Regiae Soc. Scientiarum Upsaliensis, Series IV* 16: 1–404.
- Skvortzow, B.W. 1925. Über einige Süswasser-algen der Umgebung von Peking (China). *Arch. Hydrobiol.*, 16: 337–340.
- Sladeček, V. and Perman, J. 1977. Saprobic sequence within the genus *Euglena*. *Hydrobiologia*, 57: 57-58. doi: 10.1007/BF00018627.
- Soylu, E.N., Maraşlıoğlu, F. and Gönüloğlu, A. 2007. Phytoplankton Seasonality of a Shallow Turbid Lake. *Algological Studies*, 123: 95 – 119. doi: 10.1127/1864-1318/2007/0123-0095.
- Starmach, K. 1983. Euglenophyta – Eugleniny. Vol. 3. *Panstwowe Wydawnictwo Naukowe* (in Polish), Warszawa, Poland.
- Stupina, V.V., Wasser, S.P. and Nevo, E. 2000. *Euglenophyta*. In: Nevo, E., Wasser, S.P. (Eds), Biodiversity of cyanoprocaroytes, algae and fungi of Israel. Cyanoprocaroytes and algae of continental Israel. A.R.A. Gantner Verlag K.-G., Ruggell, Israel, pp. 32-141.
- Valadez, F., Rosiles-Gonzalez, G. and Cremona, J. 2010. Euglenophytes from Lake Chignahuapan, Mexico. *Cryptogamie Algol.*, 31: 305-319. doi: 10.1007/s11160-010-9166-6.
- Varol, M. 2013. Dissolved heavy metal concentrations of the Kralkızı, Dicle and Batman dam reservoirs in the Tigris River basin, Turkey. *Chemosphere*, 93: 954–962. doi: 10.1016/j.chemosphere.2013.05.061.
- Varol, M., Gökot, B. and Bekleyen, A. 2013. Dissolved heavy metals in the Tigris River (Turkey): spatial and temporal variations. *Environ. Sci. Pollut. R.*, 20: 6096–6108. doi: 10.1007/s11356-013-1627-8.
- Varol, M. 2016. External morphological variations and temporal distribution of the dinoflagellate *Ceratium hirundinella* in two dam reservoirs in the Tigris River basin (Turkey). *Turk. J. Bot.*, 40: 112-119. doi: 10.3906/bot-1412-8.
- Varol, M. and Şen, B. 2014. Dicle Nehri'nin Planktonik Alg Florası. *J. FisheriesSciences.com*, 8(4): 252-264. doi: 10.3153/jfscom.201431.
- Vetrova Z, I (1986). Flora vodoroslej kontinental'nych vodomov Ukrainskoj SSR. *Evglenofitovyje vodorosli. Naukova Dumka* (in Ukrainian), Kiev, Ukraine.
- Wołowski, K. 1998. Taxonomic and Environmental Studies on Euglenophytes of the Krakow–Częstochowa Upland (Southern Poland). *Fragm. Flor. Geobot. Suppl.*, 6: 1–192.
- Wołowski, K. and Hindák, F. 2005. Atlas of Euglenophytes. *VEDA*, Bratislava, Slovakia.
- Wołowski, K. 2011. Euglenophyta (Euglenoids). In: John, D.M., Whitton, B.A. and Brook, A.J. (Eds), The freshwater algal flora of the British Isles. An identification guide to freshwater and terrestrial algae. 2nd ed. Cambridge University Press, Cambridge, UK, pp. 181–239.
- Wołowski, K., Poniewozik, M. and Walne, P.L. 2013. Pigmented euglenophytes of the genera *Euglena*, *Euglenaria*, *Lepocinclis*, *Phacus* and *Monomorpha* from the southeastern United States. *Polish Bot. J.*, 58: 659–685. doi: 10.2478/pbj-2013-0071.
- Zakrýs, B. 1986. Contribution to the monograph of Polish members of the genus *Euglena* Ehrenberg 1830. *Nova Hedwigia*, 42: 491–540.